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Modification of Relativistic Lorentz's Coefficient

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Abstract: We visualized a curvature path as a portion of irregular arc during the motion of particles with velocity v which is comparable to the speed of light c. This is slightly conflicts with the calculations of Lorentz's time dilation and reflects a new considered type of movement for the motion of objects without falling under the influence of other forces but under the impact of the movement of the body itself. We succeed to modify Lorentz's relativistic coefficient ɣ for time dilation in terms of $\sqrt{4h^2+b^2}+Kh$ formula for obtaining the length of irregular arc, where b and h are their base and height, and K is a constant. The relativistic Lorentz's coefficient $\frac{1}{\sqrt{(1-\frac{v^2}{c^2})}}$ becomes $\gamma = \frac{[K \pm \sqrt{K^2+(4-K^2)(1-\frac{v^2}{c^2})}]}{2(1-\frac{v^2}{c^2})}$. The calculated values of relativistic time t, Lorentz's relativistic coefficient ɣ and path length ℓ for muons are 17.29 µs, 7.92 and 5135.13 m, which are higher than that of Lorentz's (15.574 µs, 7.09 and 4625.48 m). Our results are discussed in terms of the mechanism of spiral path motion and understand a new meaning of speed changing spatially not temporally.

Key words: Curvature, Lorentz's coefficient, Time dilation and Muons.

1. Introduction

Early and according to classical Galilean transformation, the fourth coordinate of time is assumed to be the same in both inertial frames [1-4]. Consequently, the time interval between two successive events should be the same for both observers in the frames s and s`. Although this assumption may seem obvious, it turns out to be incorrect when treating situations in which v is comparable to the speed of light c as mentioned in Einstein's theory of relativity. According to this idea, Lorentz's could obtain a relationship between the proper time t_0 and relativistic time t, which is called time dilation $t = \gamma t_0$, where ɣ is relativistic Lorentz's coefficient. Interestingly, Lorentz's assumed that the upward motion of light beam in the spacecraft must be in straight line [5-6].

In 1911, Einstein's derive a mathematical expression for calculating the relative speed of light c in a gravitational potential as, $c = c_0(1+\frac{\Phi}{c_0^2})$ where Φ is the gravitational potential and c_0 is the speed of light as measured by observer at rest. In this case, the light appears to travel slower in stronger gravitational fields [7-8]. But in 1955, some

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corrections are made on the above formula to be $c = c_0(1+\frac{2\Phi}{c_0^2})$, which shows a variation twice as much as predicted in 1911[9].

However, let us consider an astronaut in his accelerating spacecraft cabin, and imagine him pointing a laser pen horizontally across the cabin. We expect the upward motion of the spacecraft would result in the path of the laser which appearing to curve slightly downwards as it crosses the cabin. This may be indicates that the light prefers to take the shortest straight line path between any two points, but only on a flat surface. While on a curved surface, we can perhaps visualize the shortest distance between two points is actually as a curve, technically known as a geodesic. However, if we combine this concept with Einstein's, then it would appear that the light in the presence of gravity follows a curved trajectory which is represented by four dimensional space-time [10-12].

2. The mathematical analysis and results

The motion of the object in straight line with a linear velocity v where v_{1x} and v_{1y} are the components of velocity is normally true for the infinite velocities which are incomparable to c as shown in Figure 1. While with high velocities which are comparable to c, we visualize a nonlinear motion which likes a portion of the circumference of an irregular arc pathway as shown in Figure 2. This of course conflicts with relativistic Lorentz's representation for time dilation. Therefore, we have done our best to modify relativistic Lorentz's transformations for the time dilation in terms of the supposed curvature motion shown in Figure 3.

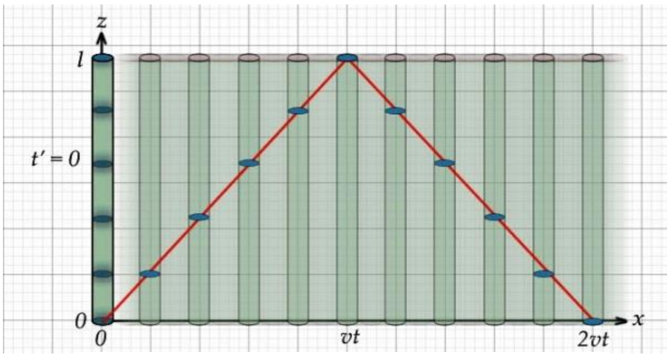

Figure 1: Diagram description of time

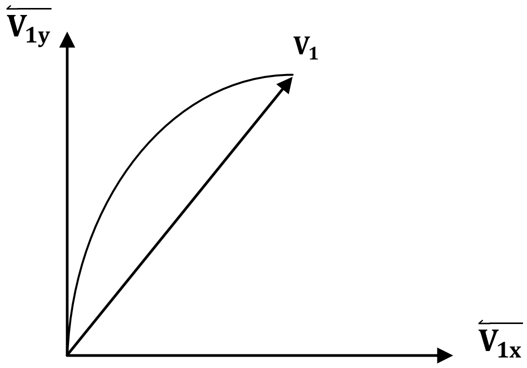

Figure 2: Diagram description of relativity curvature

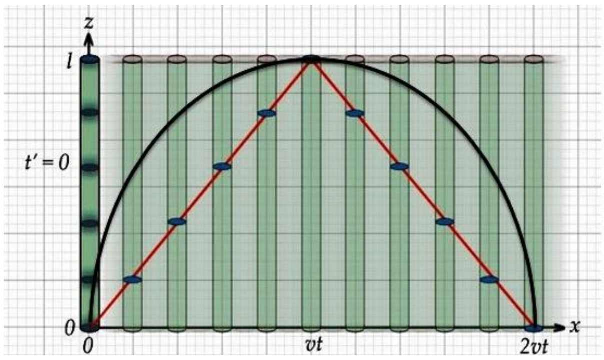

Figure 3: Diagram for description of spatial dilation

The irregular arc length as following [13];

$$\ell = \sqrt{4h^2 + b^2} + Kh \qquad (3)$$

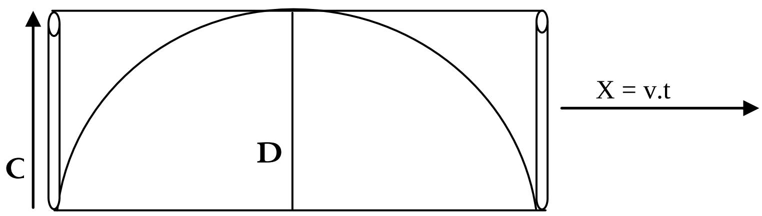

Figure 4: Mathematical description of relativity

As shown in Figure 4, the time required for the light to crossing the arc path as measured by observer in the space craft is given by;

$$t = \frac{\ell}{c} = \frac{\sqrt{4h^2 + b^2} + Kh}{c} = \frac{\sqrt{4h^2 + b^2}}{c} + \frac{Kh}{c} \qquad (4)$$

Equation (4) can be easily written as;

$$t = \sqrt{t_0^2 + \frac{v^2 t^2}{c^2}} + \frac{K t_0}{2} \qquad (5)$$

Where, $t_0 = 2h/c$ is the time measured by the observer at rest in the frame S (on the earth), and b = vt, where v is the velocity of the observer in the frame S` (space craft).

$$(t - \frac{K t_0}{2})^2 = t_0^2 + \frac{v^2 t^2}{c^2} \qquad (6)$$

$$t^2 - t_0 t\ K + \frac{K^2 t_0^2}{4} = t_0^2 + \frac{v^2 t^2}{c^2} \qquad (7)$$

Equation (7) can be written as follows;

$$t^2 = \frac{t_0^2 (1 - \frac{K^2}{4}) + t_0 t K}{(1 - \frac{v^2}{c^2})} \qquad (8)$$

or $$t^2 (1 - \frac{v^2}{c^2}) - t_0 t K - t_0^2 (1 - \frac{K^2}{4}) = 0 \qquad (9)$$

Equation (9) is quadratic equation of second-degree polynomial and its general formula are given by $ax^2 - bx - d = 0$, $x = -b \pm \frac{\sqrt{b^2 - 4ad}}{2a}$.

For simplicity, we replaced x= t, a = $(1 - \frac{v^2}{c^2})$, b = $t_0 K$ and d = $t_0^2 (1 - \frac{K^2}{4})$. By solving equation (9) in terms of a,b and d , we found that;

$$t = \frac{t_0 K \pm \sqrt{(t_0 K)^2 + 4(1 - \frac{v^2}{c^2}) t_0^2 (1 - \frac{K^2}{4})}}{2(1 - \frac{v^2}{c^2})}$$

Or

$$t = \frac{t_0 [K \pm \sqrt{K^2 + (4 - K^2)(1 - \frac{v^2}{c^2})}]}{2(1 - \frac{v^2}{c^2})} \qquad (10)$$

Equation (10) represents the time dilation which is different than that Lorentz's transformation;

$$t = \gamma t_0 = \frac{t_0}{\sqrt{(1 - \frac{v^2}{c^2})}} \qquad (11)$$

By comparing between equations (10) and (11), the relativistic coefficient γ can be written as;

$$\gamma = \frac{[K \pm \sqrt{K^2 + (4 - K^2)(1 - \frac{v^2}{c^2})}]}{2(1 - \frac{v^2}{c^2})} \qquad (12)$$

In equation (12), we have two different values of time (t), but the first value of time is higher than the other. Therefore, we have two types of velocities during the motion as represented by spiral path shown in Figure 5. The first is due to relative curvature a cross the curvature path which represents the motion of the objectives relative to each other regardless to the observer, while the other is due to self-curvature a cross the longitudinal path and away from the external forces. When the object moves across the curvature path, it will slowdown and takes a longer time than that recorded by Lorentz. But when the object moves across a longitudinal path, it moves faster and slightly takes a shorter time. The difference between these values expresses the time dilation due to relative curvature. This is required for escaping the objects from the central gravity during particle movement. For simplicity, we characterized the above mechanism as two particles move perpendicular to each other with velocities v_1 and v_2 as shown in Figure 6.

Time dilation is a very real phenomenon that has been verified by various experiments [14-16]. For example, muons are unstable elementary particles that have a charge equal to that of an electron and a mass 207 times that of the electron. Muons are naturally produced by the collision of cosmic radiation with atoms at a height of several thousand meters above the surface of the earth. Muons with a speed of 0.99c travel only about 650 m as measured in the muons reference frame, where their lifetime is about 2.197 μs. While the muons travel about 4700 m as measured by an observer on Earth. Because of time dilation, the muons lifetime is longer as measured by the Earth observer.

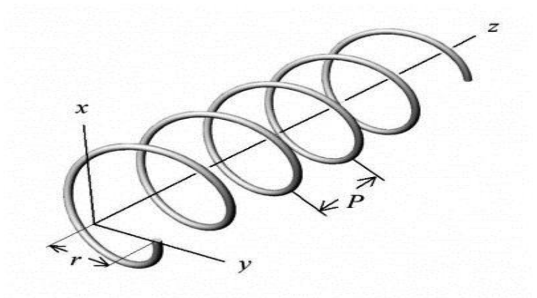

Figure 5: The spiral pathway of the object for self-curvature

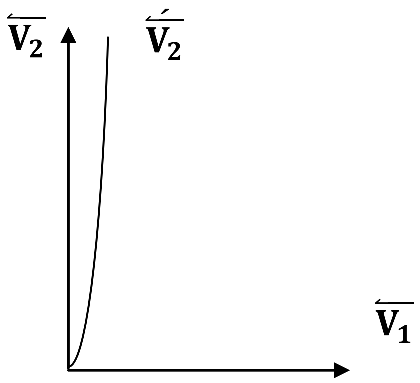

Figure 6: The diagram for the velocities of particles

Considering t_0 = 2.197 μs and v = 0.99 c for muons [17-19], and substituting in equation (12), we found that t^+ = 17.52 μs and t^- = 17.06 μs. Therefore, the average relativistic time t_p = 17.29 μs, Lorentz's coefficient γ_p = 7.92 and the average distance traveled as measured by an observer on earth $\ell p = \gamma_p v t_0 = \gamma_p\, t_p$ = 5135.13 m. While, t_L = 15.574 μs, γ_L = 7.09 and ℓ_L = 4624.29 m according to Lorentz's calculations. Therefore, the path difference between them is $\Delta\ell = (\ell_p - \ell_L)$ = 510.84 m, which is equivalent a time shift of $\Delta t = (t_p - t_L)$ = 1.72 μs. Let us return to our formula in equation (1) and recalculate the arc length ℓ in terms of b and h values. It is found that ℓ = 5280.41 m, which is very close to ℓp = 5135.13 m. However, the values of t, γ and ℓ for both cases are listed in Table 1.

Table 1: Arc length, relativistic time and relativistic coefficient

Parameters	Lorentz's	Present work	Difference
ℓ (m)	4624.29	5135.13	510.84
t (μs)	15.57	17.29	1.72
γ	7.09	7.92	0.83

3. Conclusion

We visualized a curvature path as a portion of irregular arc during the motion of particles with velocity v which is comparable to c. We succeed to modify relativistic Lorentz's coefficient to be

$$\gamma = \frac{[K \pm \sqrt{K^2 + (4 - K^2)(1 - \frac{v^2}{c^2})}]}{2(1 - \frac{v^2}{c^2})}.$$

Our calculations based on muons gave us a shifts of 1.72 μs , 510.84 m and 0.82 for relativistic time, path length and relativistic coefficient than those reported by Lorentz's. It is suggested that when the object moves across the curvature path, it will slightly slowdown and takes a longer time than that recorded by Lorentz's.

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